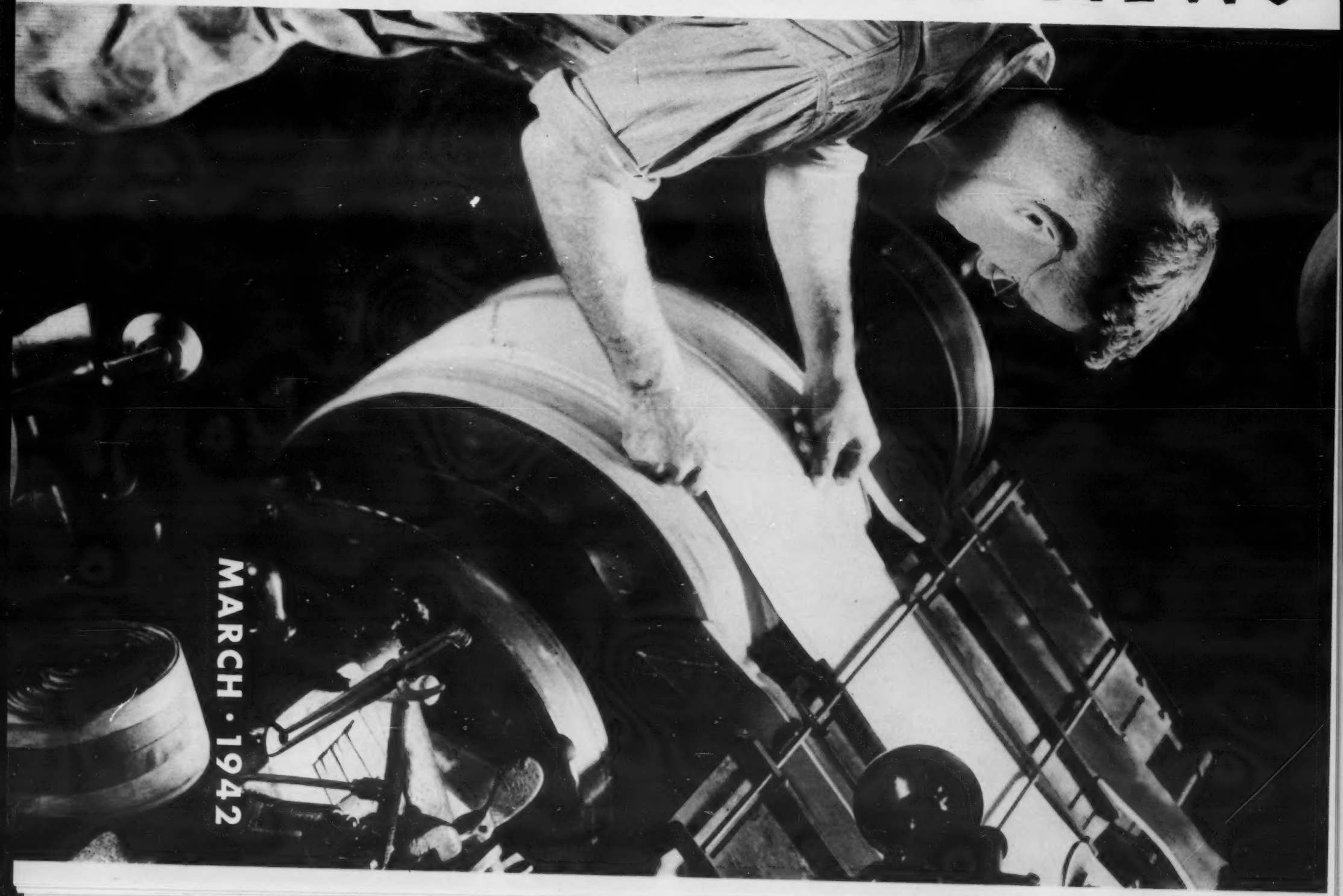
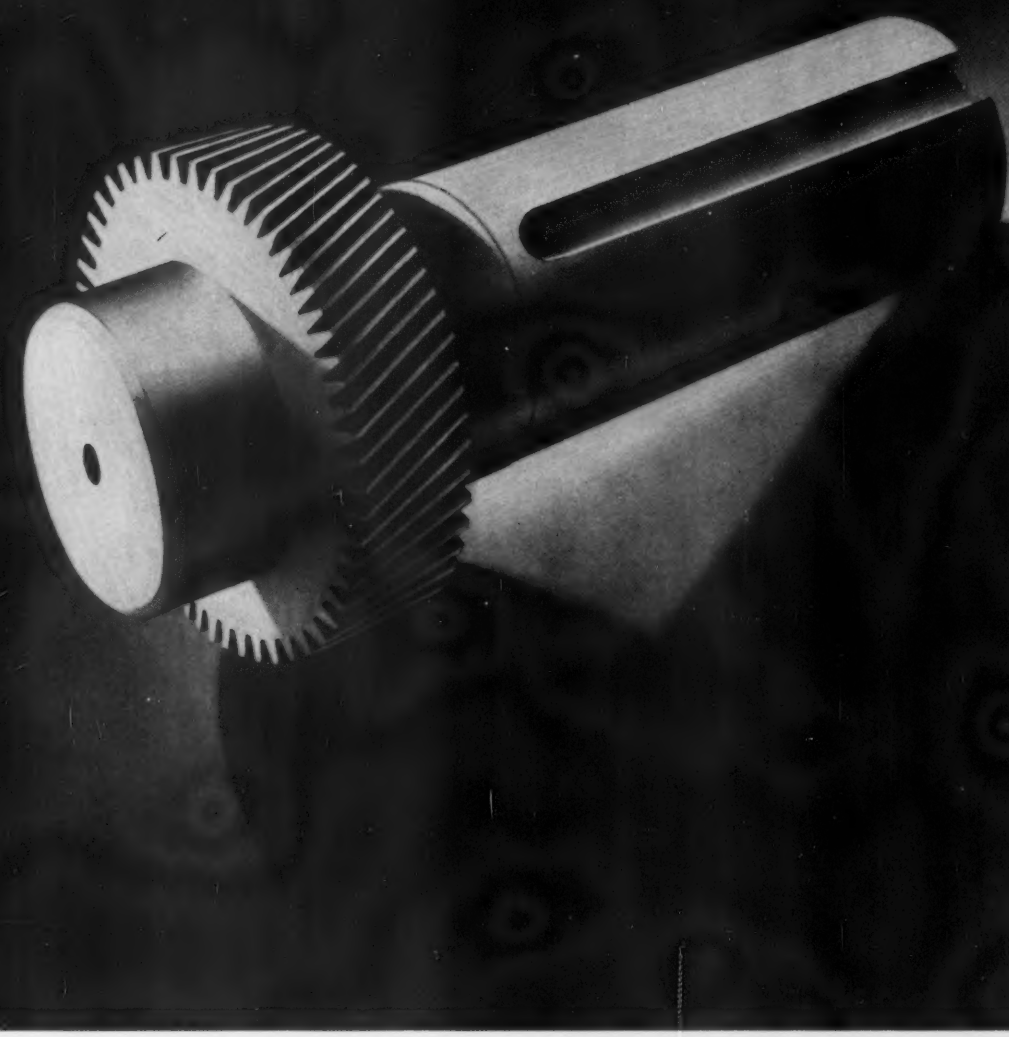
TECH ENGINEERING NEWS



MARCH · 1942

Chrome-moly steels speed production and lower costs



A manufacturer of speed reduction gear pinions is taking advantage of two of the outstanding advantages of Chromium-Molybdenum (4140) steel — uniform hardening in heavy section, and excellent machinability at intermediate hardnesses.

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CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
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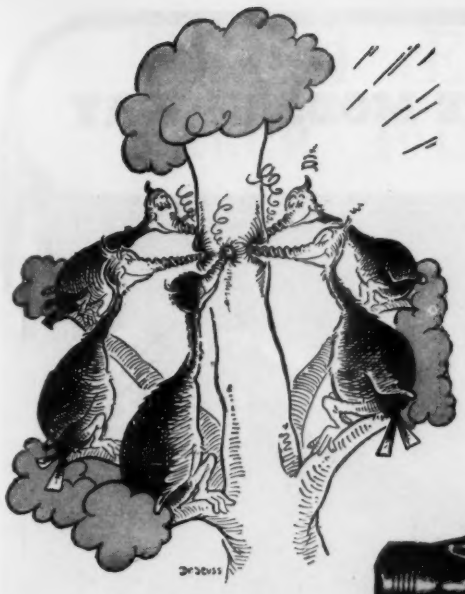
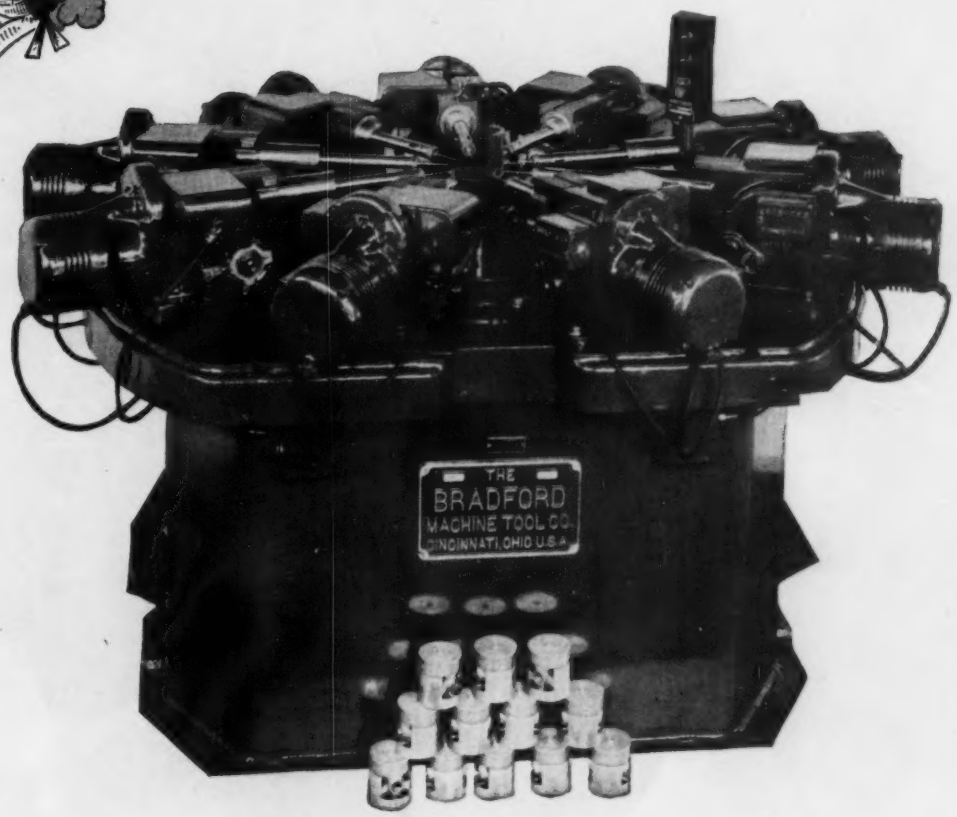


The Sapjap Calls It Heaven

He sits all day, drilling the beautiful wood. He has lots of time. Holes won't be spaced right, but he doesn't care. He thinks it's champagne—the sap.

How different his neighbor below. It has work to do—fast, accurate, continuous work. 10,800 holes per hour, 14,400 pistons per day. No time to adjust or fuss with bearings.



America Demands Speed . . .

and gets it in this 9-spindle Bradford Drilling Machine. 92 New Departure ball bearings support its rapid fire spindles and other vital parts. 92 positions where accuracy and rigidity are permanently assured. It's no Sapjap.

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New Departure

THE FORGED STEEL BEARING 3078

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So that you may become better acquainted with the many industrial applications of the Airco oxyacetylene flame, we have prepared a pictorial review of "Airco in the News".

Write to the Airco Public Relations Department, Room 1656, 60 East 42nd Street, New York, New York for a copy today.

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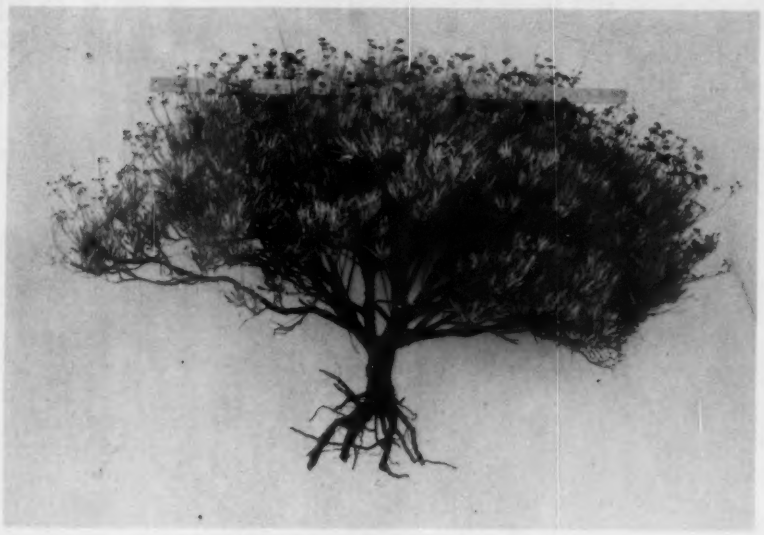
TECH ENGINEERING NEWS

MARCH · 1942

VOLUME XXIII

NUMBER 2



OUR COVER THIS MONTH

Shows a calendering operation in which cushion stock is applied to the under side of the uncured tire tread. This cushion aids in absorbing road shock, thus protecting the tire carcass against breaks.

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Dr.
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New

VITAMINS FOR VICTORY

NUTRITION RESEARCH IS VITAL TO A NATION AT WAR

By PROF. ROBERT S. HARRIS
DEPARTMENT OF BIOLOGY AND PUBLIC HEALTH, M. I. T.

IN August 1914 neither side had any suspicion that the solution of food problems would have a major influence in determining the ultimate victor. Germany opened her campaign in World War I confident that the conflict would be brief. Her high command evidently ignored the possibility that the struggle would be long and that her enemies would slowly blockade her into starvation and a malnutrition so severe that the morale and production capacity would be undermined. The working people lost their energy and became listless and despondent; they lost their respect for the laws; their nationalistic spirit was impaired; and the men in the trenches suffered a severe decline in morale.

The problem of the Allies was just as serious. Until submarine warfare was controlled, Britain was on the brink of defeat with malnutrition an important contributing cause. It is believed by some that Germany was ultimately defeated mainly because she was the first to starve.

In World War II food is again an important problem. Germany has been more careful in her food preparations. She has large areas upon which to draw and is undoubtedly making good use of the scientific advances in nutritional knowledge which have been made in the interim. For instance, Germany's chemical laboratories can manufacture by synthesis most of the vitamins needed by her people and can thus try to avoid the deficiency diseases which ravaged the health and morale of her armies and war workers twenty-five years ago.

Food problems loom large from the point of view of the United States. We entered this conflict with a people two-thirds of whom were ailing with nutritional deficiency diseases. This condition was the result of living on deficient diets containing large quantities of vitamin-depleted, refined foods, of poor food habits, and of poverty. Since it has been proven that these deficiency diseases lower the morale, cause fretfulness, laziness, nervousness, and distrust, it is evident that good nutrition is vital to all people in a nation at war. The observation that "food will win the war and write the peace" may be an overstatement. It is certain, however, that the food problem is reappearing as an important matter which must not be neglected on the battle front or on the home front.

It will come as a surprise to most readers that M. I. T. is playing an important role on the food front. Both the Food Technology Laboratories and the Nutritional Biochemistry Laboratories are actively engaged in research related to the war and the post-war period. The latter group is composed of fourteen investigators delving into the mysteries of vitamins, minerals, fatty acids and proteins, and developing mixtures and rations for use in the present emergency.

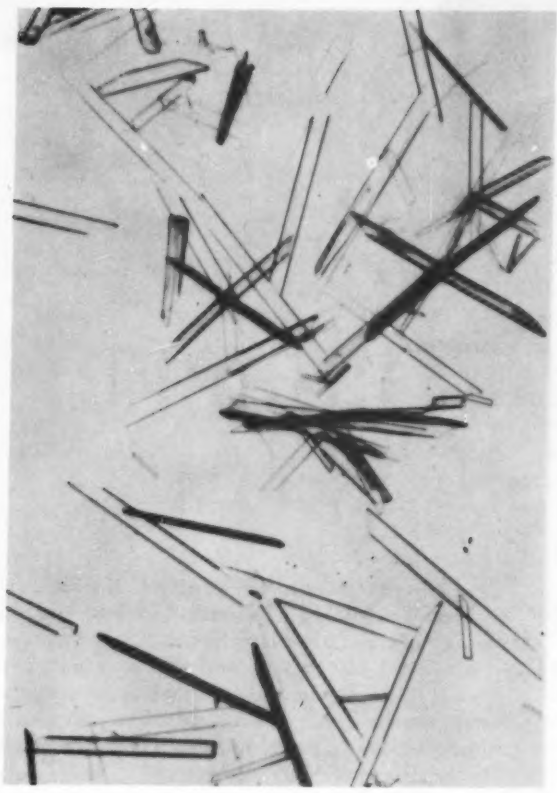
Dr. Robert Harris
in the nutrition research laboratory
News Service

The Nutritional Biochemistry Laboratories consist of four groups of workers, each led by a scientist with a Ph.D. degree or about to receive his Ph.D. degree, united together with a common purpose and interest.

The first team of three is working on fats and fat metabolism. This difficult field of research has long been neglected. For years it had been supposed that fats were of value to us solely for their fuel value, and that it did not matter how long or unsaturated the fatty acids were since they all were chopped into two-carbon chains like so much kindling. Recently it was noted that we do need certain fatty acids, that man cannot live on a diet devoid of linoleic acid without developing a deficiency disease. Fats are not only a fuel source; they also supply chemical linkages necessary for physiological health. Our researches are indicating that certain other fatty acids have special functions which are not yet clearly understood, substantiating our feeling that there is some virtue in the chemistry of food fats after all.

A second team with two investigators is working on proteins. Proteins are composed of many amino acids combined in complicated mosaics. There are more than twenty-two of these amino acids, and about half of them must be obtained in the dietary. The value of the proteins of various foodstuffs is determined by the amount of these "essential" amino acids present. Formerly the relative quality of food proteins was determined by feeding equal amounts to parallel groups of rats and noting the differences in the growth rate. This is a crude method since it gives no information as to which amino acids are lacking in an inferior protein. The better method is to determine by chemical procedures the quantities of each "essential" amino acid. Because present chemical methods are inexact, our group is engaged in the extensive task of improving these analytical procedures as well as in estimating the amino acid composition of the important food proteins.

A third team with two workers is employed on another flank of the nutrition front. During the past twenty years more progress has been made in nutrition



Vitamin B *Merck & Co.*

than in the preceding twenty centuries. This progress has been largely in discovering a number of substances needed by the body in small amounts to accomplish big tasks — the vitamins. It is likely that all of the *important* vitamins have now been discovered. Though our knowledge of what is needed in a good diet is fairly complete, our information of how much of each of these substances we need for good nutrition is woefully inadequate.

One of the most critical periods in human life is before birth, during the foetal stage. Less is known about the nutritional requirements of the pregnancy period than at any other period of the life span. Appropriately, therefore, our group is measuring these requirements, using women in a local institution as experimental subjects. The study of the thiamine requirements will be completed this fall. It is planned to follow this with a study of the riboflavin requirements, and then to continue on down the list, selecting first those vitamins which may be of critical importance to the foetus and which tend to be deficient in the dietary.

The importance of good nutrition during the critical gestation period was illustrated by a recent clinical study in Toronto. One large group of women were fed a few extra-nutritious foods for the last four months of pregancy while the dietary of a second similar group was left undisturbed. The second group showed many complications and twelve per cent of the infants died. The first group showed few complications, none of the infants died, and their health was so superior that one could pick them out from the group.

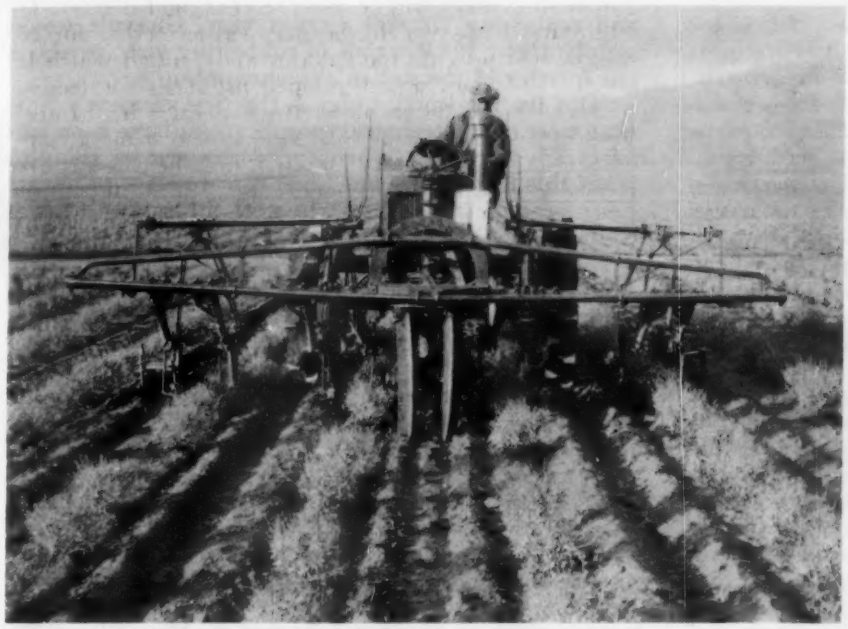
A fourth research team of five is working upon problems in nutritional engineering. One result of this work has been the development of an enriched protein soup powder, each ounce of which contains the entire daily requirements of the important vitamins and minerals and one-fifth the requirement of protein. Soup is served by adding one ounce to a cup of hot water. It requires no further cooking. Anyone consuming this cup of soup daily will be assured of a good dietary, for additional foods which he may eat in caring for his hunger will provide the calories and protein which he needs. The soup was developed primarily for feeding impoverished children under the Federal School Lunch Program. This type of food supplement, since it only costs about two cents per serving, may be of great usefulness in the feeding of populations and armies in the present war.

Two of our staff are now in Michigan in connection with a field study of the effects of the soup on one thousand children. A thorough medical examination of each child is being made by a staff of ten physicians who have been especially trained in the most modern clinical methods for the appraisal of nutritional status. After the soup has been fed for three months in conjunction with the school lunch these children will be re-examined. Thus it will be possible to measure the improvement induced by the soup supplement. Since few children are *normal* nutritionally, it is expected that considerable improvement will be observed. If effective, such a preparation might have far-reaching possibilities, not only in the school lunches of children in this country, but of other countries where the nutrition problem is even more acute. Nor need its use be confined to child feeding; in the nourishment of distressed population groups, industrial workers, and armies it would prove a simple, inexpensive, and reliable source of the critical factors which are especially scarce during periods of confusion and combat.

Another mixture which intrigues the imagination with its possibilities for feeding the masses cheaply is a single mixture which contains all the food requirements for a day in one to one and a half pounds, depending upon the calorie needs. No other food must be consumed and it is taken with water, black tea, or coffee.

This mixture is as efficient a food as present knowledge will allow. It supplies the necessary compounds (see Table I) in liberal (*Continued on page 40*)

Nicotinic acid *Merck & Co.*



Young Guayule plants being cultivated

RUBBER FROM WEEDS

THE TEMPERAMENTAL GUAYULE PLANT —ONE SOLUTION TO A VITAL PROBLEM

By ALAN S. MICHAELS '44

FOR one of the few times in her history, America is beginning to feel the pangs of hunger — hunger for vital raw materials. With the din of "Rubber Shortage" echoing in our ears, we begin a search — a desperate search — for another something that will "stretch, bounce, and take an all-around beating."

The chemist looks at rubber as an agglomeration of tangled, long-chain molecules which may be aligned by force, but return to their original state when the force is removed. Then he goes to work looking for other compounds with similar characteristics. His cheapest raw materials are coal and petroleum, and in them he finds acetylene and butadiene, basic compounds for possible syntheses. With these and other substances he builds long-chain molecular compounds with rubber-like properties, some being superior to the natural material in many ways, though inferior in others.

The rubber manufacturer says, "Look at those mountains of worn-out tires standing around useless in junk yards. Why not pool them all, and reclaim as much rubber from them as is economically possible?" And today rubber reclamation is a most important and vital activity.

Finally, the botanist puts his hand to his chin and suggests, "Hold on for a moment — the rubber tree, or *Hevea*, is not the *only* botanical source of rubber in nature. Many other plants contain a fairly large percentage of rubber. Why not try to see if cultivation of these other sources is feasible?"

The botanist may seem a far cry from automobiles and tanks and aeroplanes, but he is quite significant — and what is more, today he is on the right track. Synthesis and reclamation both add materially to our supply of rubber. But why not let nature do part of the work for us?

On the Mexican plains there grows a homely little shrub about three feet high. It is very gnarled, has small, silvery leaves, and in summer produces myriads of minute flowers. It is not anything you would want in your garden; if you found it there you would promptly pull it out as a weed. But to know its potentialities is to treat it with considerably more respect. For that ugly plant, in due time, might very well help to make the United States independent of the rest of the world for at least one-quarter of her rubber supply.

The natives call it *Guayule*. To the botanist, it is *Parthenium Argentatum*. To starving industry, it is rubber. What is more, it is upwards of twenty per cent rubber. That means one pound of rubber for every five pounds of plant. Just harvest three and a quarter million long tons of plant, and there is the annual rubber consumption of the country! It is easy to process, too. Just grind up the bush, and wash the rubber out with water by flotation. *But* — and it is a big "but" — it is not as simple as all that. 3,250,000 tons of plant means nearly 4,000,000 acres of land, and *special* land, too! And what is more, cultivation of even a small crop is a kid-glove proposition. Complications arise at nearly every turn: sowing, transplanting, seeding, irrigation, harvesting, every move requires special attention.

Guayule is a botanical problem child. "But weeds grow so well," one may say. True, but only in their own environment, and usually where they are not wanted. Guayule thrives in a hot, dry climate and in arid soil, such as that found in northern Mexico and the Big Bend area of Texas. If it is too hot and dry,

the plant shrivels up and refuses to grow. If it is too humid, its roots rot away, and it dies. If it is not quite moist enough for that, the plant grows luxuriantly, bears lots of leaves and flowers — and the rubber content drops almost to nothing. If frosts come too early, they may kill it; if they come too late, the rubber content again declines. Guayule is indeed a particular plant: If it is too hot, or too cold, too dry or too moist, one may expect either no rubber, or no bush.

In the Salinas valley of California, under the direction of the Intercontinental Rubber Company, most of the research on the cultivation of Guayule has been undertaken. In its many years of existence the company has succeeded in solving many of the problems of breeding, seeding, and cultivation. Since Guayule is a self-pollinating plant, and produces many individual flowers, cross-breeding and separation of strains was a difficult task, but finally was rewarded by the development of a plant of smaller size but of greater rubber percentage than the average. Then came the problem of nursing the seedlings. It was found that although the seeds sprouted and grew well enough in the test beds, when they were transplanted to the field they very shortly died. When it was discovered that the older plants had a different root structure from the seedlings, appropriate changes were made in the design of the nursery beds, and when then transplanted, the young plants readily took root and survived. Technical improvements were made in the spacing of plants in the field, in harvesting, seeding, and transplanting machinery, and in actual extraction of rubber from the plant. Experience has shown that the optimum age for harvesting the plant is about four to five years from the time of planting. The rubber content continues to increase beyond this point, but not to a sufficient extent to warrant leaving the plant in the ground for a longer time. With about 1,000,000 acres planted, harvesting and replanting 200,000 acres a year, Guayule would supply about 165,000 tons of rubber per year, or about one quarter of the nation's consumption.

But the big worry today is the time element. Now that most of the technical complications have been satisfactorily met with, when and where are we going to plant this huge crop, and when can we start to use it? Four years is a long time to wait for rubber. Intercontinental's experimental station in California, with 45,000 acres, can produce about 15,000,000 pounds a year. This is a sizable amount, but relative to our consumption, quite small. Congress has recently passed a law providing facilities and space for Guayule production. This great project will be very shortly under way. If necessary, a crop can be harvested in two years' time to give a fair supply of rubber. This is also a major consideration, and along with the present sources, may partially remove this national burden.

Necessity has always been the mother of invention, and the truth of that statement is especially evident today. Even if we are not able to utilize the possibilities of Guayule at the present time, or better, if we may not have to find it absolutely necessary to do so, nevertheless, we may be assured of one thing, if nothing else. America will not let herself become "short-handed" again. Then again, this short-handedness may last beyond the duration; for with the fall of Java, Sumatra, and the rest of the rubber-producing Indies along with the destruction of the vast and invaluable plantations of rubber trees, there may be no rubber available from those sources for many years to come. With this fact in mind, the value of Guayule becomes increasingly significant. From this virtually unutilized possibility there may arise a new Declaration of Independence, a new America freed from the rest of the world for its supply of a material indispensable to nearly all of our industrial activities.

Four-year-old guayule plants ready for harvesting

"FM— BROADCASTING'S SUPERHIGHWAY"

How the "Package of Sound" gets into your home
ON AM BROADCASTING
ON FM BROADCASTING
FULL-SIZED "PACKAGE" STARTS IN AM STUDIO
ENTERS MICROPHONE
ALREADY REDUCED IN SIZE
ON AM HIGHWAY "PACKAGE" MEETS ELECTRICAL DISTURBANCE
INTERFERENCE
FADING TUNNEL
ENTERS AM RECEIVER
AM SET DELIVERS SMALL AND BATTERED "PACKAGE"
FULL-SIZED "PACKAGE" STARTS IN FM STUDIO
ENTERS MICROPHONE
STARTS JOURNEY FULL-SIZED
TRAVELS ON BROAD FM HIGHWAY WITHOUT INTERRUPTION
FM HIGHWAY
FM SET DELIVERS FULL-SIZED, UNDAMAGED "PACKAGE"

HOW FM RENEWS TODAY'S OBSOLETE RADIO CHANNELS

By L. McCANN '27

ASSISTANT GENERAL MANAGER STROMBERG-CARLSON

UNTIL 1941, the radio broadcasting stations in this country have been using the same "dirt road" system of highways or "channels" for programs set up twenty years ago, when KDKA started a daily schedule of broadcasting.

In the meantime, many a railroad has rebuilt its roadbed again and again, with heavier rails at standard gauge, smoothing out curves and grades, eliminating tunnels, bridges and congested traffic areas so as to handle greater loads at higher speeds with more safety. And as for automobile roads, a conspicuous difference exists between the modern eight-lane parkway with grassy islands down the center, grade crossings eliminated, hills and curves flattened out and the best "State road" available to the car driver twenty years ago.

Part of the reason why radio's highway system has been "frozen" so long is that we have a Federal licensing system to tell each broadcasting station how it can operate. The primary reason for this licensing, of course, is to protect the people — the listeners who have invested in a portion of the broadcasting system: their receiving sets. In automobiles, the owner of the oldest "Model T" can still drive the most modern superhighway. In railroading, the railroads own the whole system, roadbed and rolling stock, and can take obsolescence in their stride with proper care as to standardization. But in radio, the quantity and width of the highways available had been frozen for an extraordinarily long time, as radio goes.

In the meantime, traffic conditions on radio's highways have gone from bad to worse and become almost unbearable. In the beginning, 96 channels — each 10 kilocycles wide, with no unused "guard band" or traffic island between them — were set aside for broadcasting, from 550 to 1,500 kilocycles. This was the standard broadcast dial. After 12 years, this dial was extended to 1,600 kilocycles for three experimental high fidelity channels, but with one notable exception — WQXR New York City — these high fidelity channels have now been sacrificed and (*Continued on page 38*)

The effective use of protective lighting — *Westinghouse*

LIGHT VS. SABOTEURS

INDUSTRY DRAFTS ILLUMINATION TO COMBAT SEDITIOUS ACTIVITIES

By ROBERT G. CLARK

"HITLER'S SPIES AT WORK IN MUNITION FACTORY"

"JAP SABOTAGE SUSPECTED IN CALIFORNIA PLANT"

"200 SHIPBUILDERS STRIKE AT EAST COAST PLANT"

Haven't you seen headlines such as these on the front pages of newspapers all over the country? Doesn't it make you wonder what can be done? Doesn't it make you realize that no matter how great our sacrifice or how united our effort successful sabotage could set our war production months behind schedule? Europe's experience with fifth columnists should be convincing evidence of how a nation's defense can be weakened by organized sabotage working from within.

Even before this nation was at war, the FBI investigated daily over 200 sabotage and espionage complaints. The fact that most of these complaints were from industrial plants engaged in defense work indicates that fifth columnists are already actively at work in this country. Since December 7, the FBI has taken into custody 5,100 alien enemy agents which is also a good indication of the powerful force that is working to undermine our security.

How Can Industry Defend Itself?

Unfortunately, there is no one answer to this question although there are many excellent solutions which are being widely used and recommended by the FBI Protective lighting is one of these effective solutions, and has become industry's first line of defense. Lighting alone, however, is not the complete answer to the problem. The following precautions should also be taken if the protective lighting system is to be completely effective:

1. Good employee training.
2. Identification system for all employees and visitors.
3. Emergency power supply.
4. Adequate number of guards.
5. Well constructed, high fences.
6. Tamper-proof telephone and alarm system.

Principles of Protective Lighting

1. Discourage any attempts at entry by:

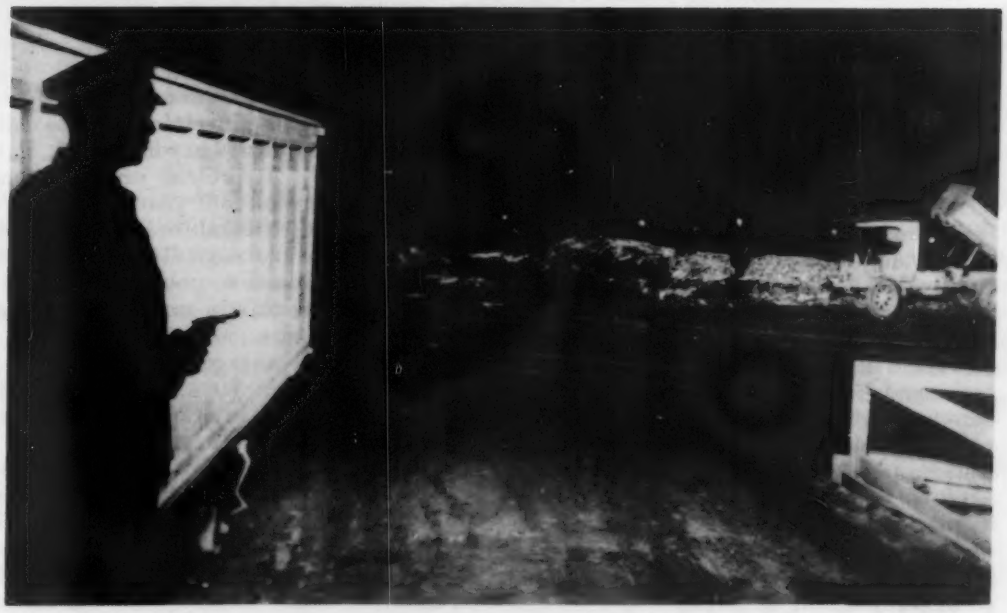
(*a*) Planning the lighting system so complete that the saboteur will conclude that detection would be certain and that he'd better remain on the outside.

(*b*) Directing glare into the eyes of the intruder to prevent his seeing within the property and determining the location of the guards.

2. Make detection a certainty assuming entry has been made by:

(*a*) Providing a lighting layout engineered to leave *no flaws* since a single flaw will make the entire installation worthless as night-time protection.

(*Continued on page 46*)



Westinghouse

With the engineered protective floodlighting system the intruder entering the blinding glare of the system can easily be detected (top). He is prevented from seeing clearly by the glare (center) and the watchman behind a "screen of light" is ready for any emergency (bottom).

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PENNSYLVANIA TRIANGLE
PURDUE ENGINEER
ROSE TECHNIC
TECH ENGINEERING NEWS
VILLANOVA ENGINEER
WASHINGTON STATE ENGINEER
WAYNE ENGINEER
WISCONSIN ENGINEER

FRANKLY SPEAKING . .

LET'S MAKE DEFENSE OUR BUSINESS

It seems remarkable to think, today, that only a few years ago the big problem in the United States was to find jobs for our manpower, thrown out of work by the depression. Those were the days when we were being taxed, rather heavily we thought, for the maintenance of such projects as the alphabetical government bureaus CCC, WPA, PWA, AAA, and others which Washington was using in an effort to ease the economic strain.

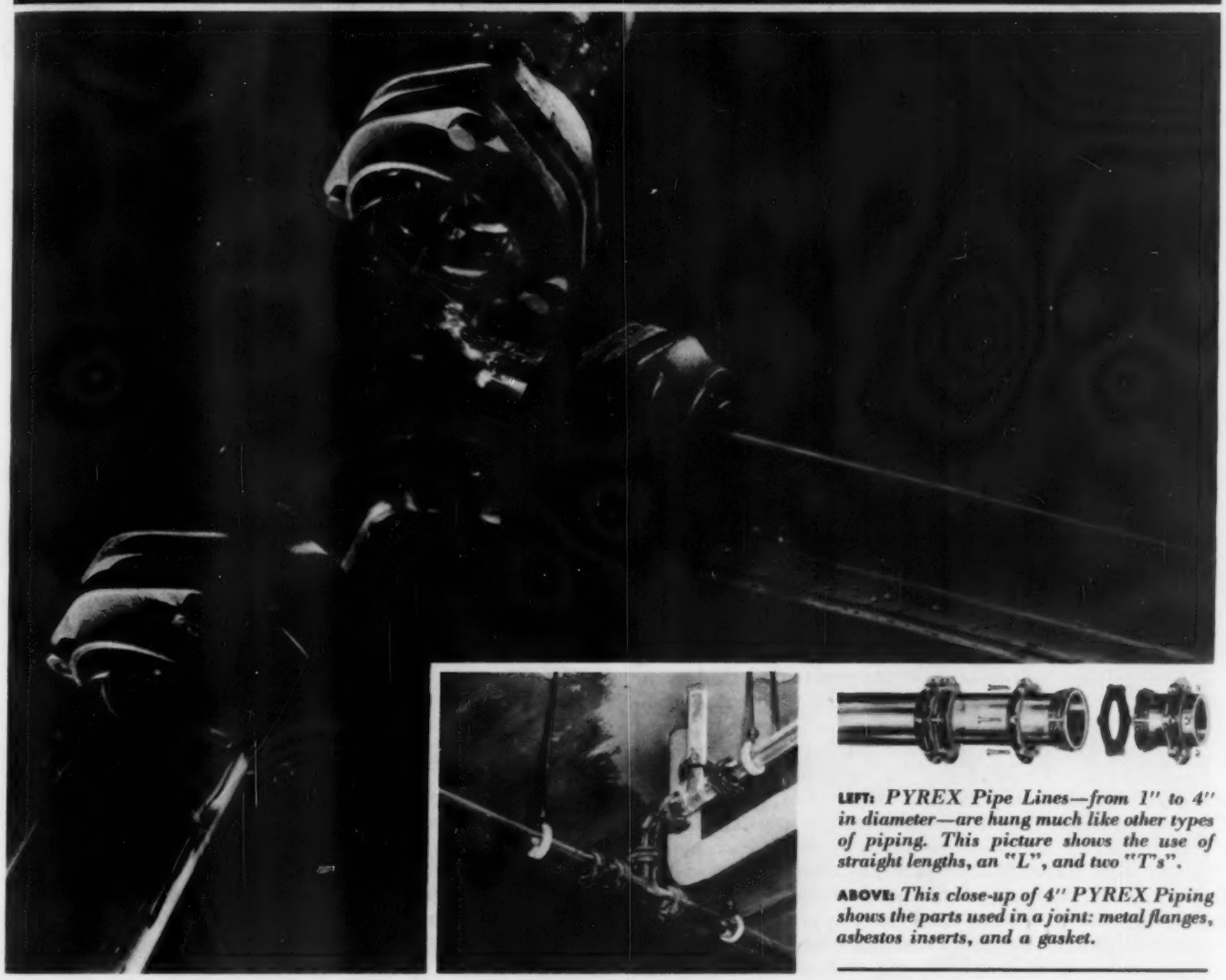
Today, with the sudden shift from a condition of excess manpower to one in which the manpower is quite insufficient, we are beginning to appreciate more fully the value of governmental efforts in the past few years, and especially in the interval preceding our declaration of war. The various job-manufacturing agencies have performed the triple function of keeping idle workers occupied until needed; giving Washington practice, so valuable now, in controlling complicated bureaucracies; and, through expenditure of large government payrolls, they have expanded credit somewhat, helping industry to be a little better prepared for the present emergency. This extra expense, felt through taxes, has also made the war economy come a bit easier for the American public. Of course, many things, such as economic and military mobilization, more directly related to national defense were not generally acceptable until considerable time had been lost. We must now make this loss good.

M. I. T. is being affected by this problem in two ways: in the first place, those students who will not be studying here at the Institute this summer are being asked to get jobs in industry, and they are being backed to the limit by the school in obtaining such work. Tech does not parcel out jobs, though, it is the responsibility of each student to go after a prospect and land his own. In the second place, men in the advanced R.O.T.C. must face the probability of going into active service on graduation, and many others, as yet with but two years of training, will be called by the draft. These are two ways in which M. I. T. will do its share for defense.

At present we are among the few schools carrying on full four year courses. We are also fortunate in having liberal military deferment privileges. By going wholeheartedly into summer employment we have the chance to prove that a four year course is not going to mean any man-hours wasted, and that, even as students, we intend to help make up the initial time advantage lost to the Axis.

As far as military service goes, a new problem has arisen in drawing the line between soldiers for the army and workers in industry. Formerly, engineers and machinists were considered more valuable to Uncle Sam working in a munitions plant than in the army. Now that war is something more than "just shooting," people are having difficulty realizing that just "manpower" is not quite as good as "trained manpower," and that the army has a need for intelligent, trained men of all sorts almost as urgent as the need of industry. It is for this reason that many students must expect to apply their training and aptitudes in the army rather than in industry within the next few years.

The pipe that can't keep a secret...



LEFT: *PYREX Pipe Lines—from 1" to 4" in diameter—are hung much like other types of piping. This picture shows the use of straight lengths, an "L", and two "T"s.*

ABOVE: *This close-up of 4" PYREX Piping shows the parts used in a joint: metal flanges, asbestos inserts, and a gasket.*

THIS ginger ale maker is as finicky as a New England housewife. (Probably why his ginger ale is an Eastern best-seller.)

"I want pipe I can see through", he said, "so I know it's clean. Pipe that can't alter the flavor of my product any more than the glass bottles it is sold in. Darn it, I want glass pipe!"

Glass pipe lines, made by Corning, are a familiar sight in food, beverage, and chemical plants . . . paper mills, refineries, explosives factories . . . drug, medicine, and cosmetic plants . . . in short, wherever product purity is vital.

Highly resistant to corrosion attack, Corning's PYREX Piping eliminates this cause of contamination. Transparent, it keeps no secrets . . . a glance tells of flow, cleanliness, color, sedimentation. And freedom from pitting and scaling means long life for these pipe lines, with low maintenance costs.

Important? Yes. For in today's urgent program there's no place for impure products, production stoppage, high maintenance costs, or wasted materials. And in many instances, glass has proved it can outperform metals, do an essential job better and at a lower cost.

To the engineer, this glass piping is important as an example of the many-sidedness of glass in industry and of Corning research in glass . . . research that takes in its stride such divergent tasks as the making of a tiny chemical-resistant glass spring, smaller than your thumb, or the casting of the world's largest telescope mirror, a giant one-piece disc 20 tons in weight. Today more than ever Corning is headquarters for research in glass. Industrial Division, Corning Glass Works, Corning, New York.

CORNING
means
Research in Glass

"FM — BROADCASTING'S SUPERHIGHWAY"

(*Continued from page 33*)

broken down into ordinary channels to make room for more stations.

Of course, most radios eight or more years old cannot tune in these additional channels between 1,500 and 1,600 kilocycles. Several of these original channels were assigned exclusively to Canada; later others were shared with Canada, and Canada extended the dial one channel in the other direction: to 540 kilocycles.

In almost no time, American broadcasters sprang up seeking licenses that would more than fill up the dial. Every school, church, newspaper, department store or municipality that wanted a broadcasting station set up its own political clamor to obtain a license. The Department of Commerce set up a division, the Federal Radio Commission, to control this situation, and began licensing two or more stations to share the same channel. Many of these stations requested more and more power, and additional applicants clamored for space on the dial. In desperation, the Department of Commerce turned the problem back to Congress who set up a Federal Communications Commission to examine every broadcast application to determine whether it was in the best public interest, convenience or necessity. Even so broadcasters occasionally have been able to force the hand of the Federal licensing body in the courts. For instance, the Commission's engineers recommended that forty channels be "cleared" for exclusive use of one high-powered station, but the Commission has not been able to carry out this desirable recommendation. In the meantime, microphones, loud speakers, and chain network telephone lines have been improved to handle a bigger package of music — including the overtones necessary to transmit the timbre or quality of the music — whereas the original carbon microphone and receiving sets were designed principally for speech and the bare pitch range of musical instruments. These broadcasting channels, crowded tightly together side by side on the dial, are not wide enough to deliver this full package of music, with its overtones that make speech more intelligible and music much more natural. Therefore, as these improvements were made, the broadcasting stations exceeded their own assigned channel and overlapped other broadcasting channels so that if stations using either adjacent channel could be heard, there was bound to be a clash of heterodyne whistles, cross-talk or monkey chatter where these programs overlapped.

It was found necessary to space local stations in the same community or regional area at least five channels apart so that, roughly, only seventeen local stations at most could be accommodated for large cities like New York and Chicago. Radio receivers had to be made more and more "selective" to keep this traffic tangle from becoming intolerable. Then, too, listeners learned to turn down the tone control because the low notes are transmitted near the middle of a station's channel, while the high-pitched tones are out near the edges of the channel; and the overtones are out beyond the limits of the channel, where they may clash with high tones and overtones from an adjacent-channel station. This misuse of the tone control, for the sake of quietness, results in exaggerated, dull, tubby bass reproduction which soon tires the listener.

Today, there are 890-odd broadcasters operating on this "AM" or standard broadcast dial. Transmitter power has been stepped up from 500 watts to 5,000 watts to 50,000 watts, and 500,000 watt transmitters have been tried and abandoned, at least temporarily. Broadcasting stations across the continent that used to be heard on five kilowatts are now drowned out using fifty kilowatts on even more sensitive receiving sets, in the general hash of interference caused by having too many stations or too few channels. The situation looked hopeless until FM came along.

FM is Revolutionary

Up to this point, all commercial broadcasting had been accomplished by "Amplitude Modulation." The process of broadcasting consists of (1) generating a carrier wave which will radiate from an antenna and can be used to transmit dots and dashes or speech or music and, (2) of super-imposing the program on that carrier wave in any suitable way. In Amplitude Modulation, the carrier wave is relatively fixed in frequency — held within close limits by a crystal control — but the program is made to vary the carrier power or amplitude.

It has long been known that the program and the carrier could be mixed together in another way, keeping the power or amplitude of the carrier steady but causing the program to "swing" the carrier frequency. Looking for a means to eliminate static, Major Edwin H. Armstrong — inventor of the regenerative, super-regenerative and superheterodyne circuits, one or another of which is used in more than ninety per cent of all vacuum tube receivers — determined that static had the same form or character as an amplitude-modulated wave. He decided, therefore, that frequency-modulated transmissions would help to eliminate static; the static could be filtered out by some devise that would discriminate against amplitude-modulated waves (steady frequency, varying power) yet would pass frequency-modulated waves (swinging frequency, steady power).

Starting from this premise, Major Armstrong developed radically new receiver circuits which not only brought about virtual immunity to natural static and man-made static, while accomplishing transmissions which are almost breath-taking in their lifelike tone range and dynamic range, but also introduced two features brand new to radio.

1. The possible elimination of most of the circuit noise or system noise due to vacuum tubes and other elements of the transmitter and receiver. In a properly designed FM receiver and system, the carrier hiss, hum and background noise is gone. The radio does not even sound "alive"; everything seems silent until the music plays. Of course the audio circuits at the transmitter and in your receiving set need be designed for quiet operations and the absence of hum.

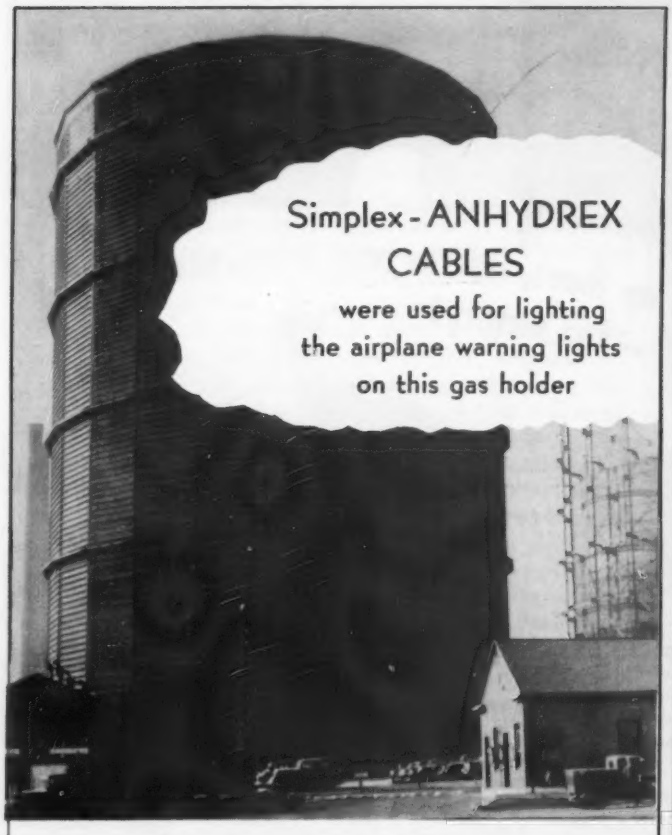
2. Possible elimination of interference between FM stations transmitting *on the same channel*. We use "possible" advisedly in stating both of these features because (*a*) the desired program must be received stronger than the unwanted interference, to keep control and (*b*) many so called FM radios are being manufactured which do not include all of Major Armstrong's circuit developments to accomplish these features, and the system should not be judged on the basis of these incomplete sets.

The future importance of sharing FM channels without interference has never been told. Yet it is, undoubtedly, one of the chief reasons why the Federal Communications Commission gave its blessing to FM and, for the first time, set up a whole new system of broadcasting channels: new superhighways for better service to those equipped to receive programs by FM.

(*Continued on page 43*)

More aluminum up there, less in new telephones —for victory!
Many materials used in telephone making are listed as "critical" for war purposes. Bell Telephone Laboratories and Western Electric have redesigned apparatus and changed manufacturing methods to employ available materials.
Take aluminum. The reduction in its use in a year's telephone output is enough to build 294 combat planes. This program has been replacing critical materials at an annual rate of 7,747,000 pounds. Though it grows steadily more difficult to maintain as shortages increase, the program helps to meet the greatest demand in history for military and civilian communication equipment.
"THOSE PLANES WILL HELP DADDY LICK 'EM!"

Western Electric ... is back of your Bell Telephone service



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THE MURRAY PRINTING COMPANY
KENDALL SQUARE, CAMBRIDGE

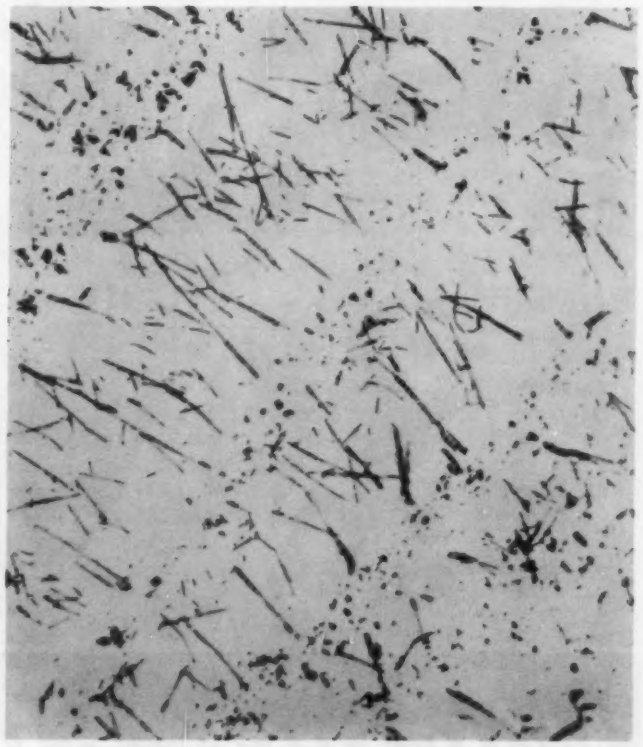
VITAMINS FOR VICTORY

(*Continued from page 30*)

quantities and avoids the large excesses of unneeded compounds commonly obtained in the ordinary dietary. The materials in a daily ration cost less than five cents; it is stable, ships easily, is bland in flavor, and, according to those who have lived on it for four weeks, it is not unpleasant to live on.

The daily press seems to relish the thought that eventually mankind will be nourished by capsules or tablets. Though this might be a boon to bridge-playing wives, it is a figment of the imagination. Try as we may, the daily food intake of the average person cannot be reduced below a pound. In Table I we demonstrate this by calculation. One would have to eat a large number of capsules or tablets to obtain his three meals a day — and it would certainly be uninteresting.

The synthesis of vitamins has made it possible to obtain good nutrition more cheaply. In Table II we present the result of a calculation of the cost of the important vitamins needed by an adult each day. These prices represent what a food or pharmaceutical manufacturer would pay for vitamins he might add to his product. It is evident that the enrichment of the cheap, staple foods which constitute almost the entire dietary of a large mass of the population would make it possible for them to purchase a good dietary at little, if any, increase above present cost. The public, in its folly, insists on eating refined foods, even though it knows that malnutrition is the necessary result. For trade reasons the food industries must cater to the palate of



Pantothenic acid — *Merck & Co.*

SAMSON SPOT SASH CORD

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Made of extra quality cotton yarn, carefully inspected, and guaranteed free from all imperfections of braid or finish.
The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds, and colors for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes; also cotton twines.

CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST

SAMSON CORDAGE WORKS **89 Broad Street, Boston 9, Mass.**

the public. But it would seem that the manufacturers of refined foods should "enrich" their products with vitamins and minerals, until the finished product is equal to the unrefined product in nutritive value. A campaign is now underway to educate the public to demand enriched bread. It costs no more, tastes the same, and is a much better food than bread made from ordinary flour, approaching whole wheat bread in food value.

Our research group is housed in four laboratories resembling chemical laboratories, except for the special instruments required in the research: fluorometers for the measurement of thiamine and riboflavin, spectrophotometers for estimating vitamin A, niacin, hemoglobin, etc., fermentometers for measuring thiamine and its intermediates, and so on. Muffle furnaces, balances, burettes, flasks, chemicals and all the equipment of the chemical laboratory are there as well.

We have a vitally important fifth laboratory which houses a large group of white rats. In the few years of our activity we have employed over 27,000 white rats — employed because they too are an important band of research workers. Few people realize the importance of the part played by the rat in the phenomenal advance that has been made in nutritional science. Until the recent development of physical and chemical instruments for measuring vitamins, the rat was our sole indicator. Spectrographic methods are remarkable in detecting small quantities of material, but not nearly as remarkable as a rachitic rat, for instance, who can detect for us as little as 0.0000002 grams of vitamin D in 40 grams of sample, with no false positives. We cannot easily eliminate the rat from a nutritional research laboratory for he is the final judge to tell us with certainty that a compound is a vitamin. Only the rat can tell whether a compound is nutritionally useful, for there are no known chemical or physical methods which will inform us whether a substance can be absorbed from the intestine, and how much will be absorbed.

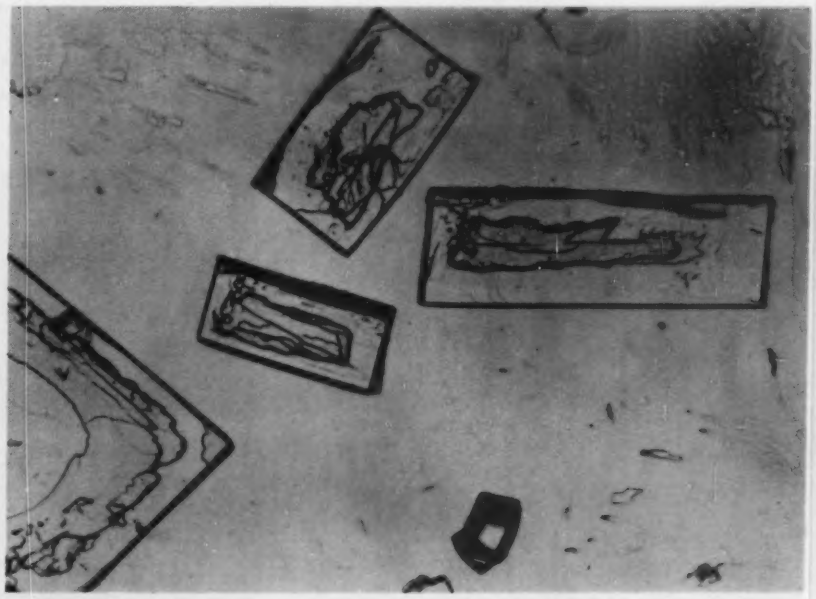
One of the prime causes of war is lack of sufficient food to nourish a nation. If human beings were as docile as cattle it would be possible to feed mankind for less than twenty dollars per person yearly with food mixtures resembling cattle feed, highly nutritious but low in what is called palatability and zestfullness. Possibly a better solution of the problem of feeding the world lies in the use of simple food supplements rich in the critical vitamins, inexpensive and palatable. Such preparations do not entail a change in food habits which are deep-rooted in the lives of the various races and allow a continuance of the dietaries already available to each community of people. After the war it will be our problem to assist in the restoration of trodden, valiant nations, to rebuild the malnourished bodies of these peoples to buoyant health again. In this emergency, scientists must slight their research on constructive basic problems and apply their knowledge to the problems of the war and post-war period. The Nutritional Biochemistry Laboratories are taking an important part in this stupendous effort.

TABLE I. CHEMISTRY OF NUTRITION

(Daily requirement of an average person)		*Weight Grams*
Calories: Carbohydrate (160), fat (263)		423.00
Protein (amino acids)		36.94
Valine (4.22)	Methronine (2.53)	
Leucine (5.49)	Histidine (2.11)	
Isolencine (3.80)	Arginine (2.11)	
Phenylalanine (5.70)	Lysine (6.33)	
Tryptophane (1.70)	Threonine (2.95)	
Minerals		14.48
Calcium (0.80)	Magnesium (0.26)	
Phosphorus (0.80)	Potassium (2.47)	
Iron (0.015)	Sodium (5.17)	
Copper (0.0003)	Chlorine (3.94)	
Iodine (0.00013)	Manganese (0.021)	
Sulfur (1.00)	Zinc (0.000015)	
Cobalt (?)		
Vitamins		0.11
Vitamin A (.000566)	Vitamin B_6 (.006)	
Thiamin (.002)	Ascorbic acid (.075)	
Riboflavin (.003)	Vitamin D (.00001)	
Niacin (.020)	Vitamin E (trace)	
Kantothenic acid (?)		
Total Minimal Food Intake		474.53

TABLE II. COST OF IMPORTANT VITAMINS REQUIRED BY AN ADULT DAILY

Vitamin	*Daily Optimum*	*Cost per day*
A	5000 I.U.	0.0012
B_1 (thiamine)	2 mg.	.0011
B_2 (riboflavin)	3 mg.	.0030
Niacin	20 mg.	.0008
C (ascorbic acid)	75 mg.	.0053
D	400 I.U.	.0001
		$0.0115



Vitamin B_6 *Merck & Co.*

Return of the Carbon Age

CARBON . . . one of Nature's oldest and most plentiful materials . . . is making possible some of industry's newest achievements.

In the *chemical* industry, massive black towers of carbon . . . erected in incredibly short periods of time . . . speed the delivery of vital acids. The all-carbon electrostatic precipitator . . . built of carbon from the bottom to the top of the stack . . . is now an actuality. Such towers can be erected in as little as a *week's time!* Staunchly immune to corrosion and thermal shock, they should last *indefinitely*.

Today . . . due to basic and applied research into the properties of carbon and graphite . . . it is possible to obtain these black, wonder-working materials in such a variety of forms—blocks, bricks, beams, tubes, pipes, and fittings . . . even valves and pumps . . . that almost any size or shape of structure can be built from them. For making tight joints, which give the structure uniform properties throughout, special carbon- and graphite-base cements have been developed.

Undisturbed by the torture of heat, carbon is also a "must" in the *metallurgical* industry. Carbon *cannot be melted* . . . will not soften . . . and has remarkable dimensional stability even at incandescent heat. In addition, it will not flake off and hot metal will not stick to it. That is why it is ideal for such uses as molds, cores, and plugs . . . for the lining of furnaces . . . and for sampling-dippers.

Because electric-furnace graphite conducts heat even *better than most metals*, it is becoming increasingly important in the manufacture of heat exchangers for the processing of corrosive liquids and gases.

These new uses for carbon and graphite . . . added to the almost interminable list of uses that existed before . . . make this era truly a carbon age. Your inquiries are cordially invited.

The strides made in the development of structural carbon, and in the uses of other carbon and graphite products, are greatly facilitated by the technical assistance of other Units of Union Carbide and Carbon Corporation including The Linde Air Products Company, Carbide and Carbon Chemicals Corporation, Electro Metallurgical Company, Haynes Stellite Company, and Union Carbide and Carbon Research Laboratories, Inc.—all of which collaborate with National Carbon Company in research into the properties and applications of carbon and graphite.

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BABCOCK & WILCOX

"FM — BROADCASTING'S SUPERHIGHWAY"

(*Continued from page 38*)

FM's advantages in tone range, freedom from static and absence of system noise have been relatively well explained to the public; and, undoubtedly, account for rapidly mounting AM-FM receiver sales. Many purchasers who were skeptical at the outset now report that they do most of their listening by FM and will do more, if not all their listening, when a greater variety of programs is available on the FM band. To make this easy for them, the leading AM-FM receiver manufacturers have developed automatic push button tuning attachments whereby pushing a button marked for the call-letter "numbers" of an FM station automatically switches the range switch to FM, switches the audio system for high fidelity, and tunes in the wanted station all at the same time; whereas pushing a button marked with an AM station's call letters automatically switches back to the AM band, to standard fidelity, and tunes in the station.

To the question, however, "Why start a new broadcasting system now?", a thrilling answer could be told. This new FM broadcast band provides a complete new set of superhighways for better service without traffic congestion. Then, when much of the present traffic has been shifted to FM, the opportunity may present itself to *rebuild radio's original AM highways* so as to give better service to all listeners, AM or FM.

This is a long-time program, no doubt too far-fetched for explanation to the general public at this time. The initial step of setting up new stations to use the new highways has met with unforeseeable impediments having nothing to do with FM versus AM. These include (*a*) the war, calling for strict husbanding of scarce materials, (*b*) the Government's questioning newspaper ownership of broadcasting stations, AM or FM, (*c*) anti-trust "monopoly" action against the major broadcasting network chains and (*d*) the recent controversy over the right to use ASCAP copyrighted music. Any one of these deterrents, though temporary, might be expected to discourage broadcasters from investing in new transmitters.

One by one, FM stations continue to take to the air, however, and the sales of receiving sets show a growing trend toward AM-FM models. Owners of these receivers are the cream of the crop of listeners, those with the best purchasing power. They have made a larger investment for the privilege of listening on FM. AM-FM sets will always cost more than straight AM radios; they include everything that the AM set has plus many more parts. The main difference in cost, however, goes into a loud speaker and audio system capable of doing justice to FM — for better reproduction than is needed or practical for most listeners today on the AM dial, due to its static and overcrowded traffic conditions.

It is not surprising that the general public is willing to spend considerably more for an AM-FM set. In many parts of this country clear, full-toned, night-time reception of even one AM program is impossible under all weather conditions, and if you cannot get one program clearly your set is (*Continued on page 45*)

The heat treatment that contradicted itself

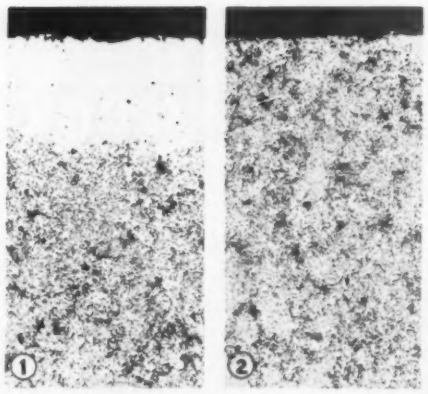
How Westinghouse Engineers straightened out a paradox in steel

METALLURGISTS have been heat-treating steel for 2,500 years. They've taken steel parts, subjected them to heat, cooled them quickly by quenching them in water, oil, or gas, and so hardened them.

But the heat treatment contradicted itself.

For while they were heat-treating the steel to harden it . . . they also softened it. As the steel was being heat-treated, oxygen combined with the surface carbon, decarburized and softened the surface.

Naturally, metallurgists had to remove this softened surface. They had to pickle, grind, or machine the surface—processes



This photomicrograph of SAE-6150 Spring Steel shows .005" decarburization with ordinary scale-free atmosphere.

This photomicrograph of SAE-6150 Spring Steel shows no decarburization with Endogas atmosphere.

which not only wasted time and cost money but also accounted for a whole lot of inefficiency.

The dimensions of many steel parts, especially dies, have to be accurate to a few thousandths of an inch. So, metallurgists had to make the steel parts larger to start with, just enough larger so that they'd be the right size after the softened surface had been removed. And that left room for plenty of mistakes.

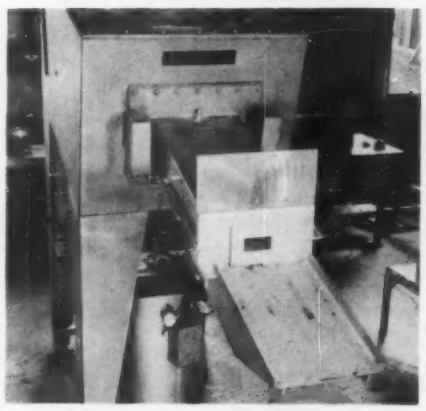
▸ Something, Westinghouse engineers decided, should be done to get rid of all this heat-treating trouble.

They figured the thing to do was to find a way to keep carbon-hungry oxygen from getting at the steel surface. And that was the thing they did.

First, they settled on using an electric furnace since it would give them accurate temperature control and entirely eliminate gas fumes. Then, they created a special atmosphere for the furnace. They heated ammonia (NH_3) in the presence of a catalyst and separated it into its component parts, nitrogen and hydrogen. The nitrogen is inert and won't combine with anything. The hydrogen, in the absence of oxygen and water vapor, also refuses to have anything to do with the carbon.

In this special atmosphere, which Westinghouse engineers called Ammogas, steel parts could be treated with electric heat and . . . no softening of the outer surface took place, no time-wasting, inefficient finishing had to be done. The dies and other steel parts came out of their heat treatment bright, shiny, all ready to use.

▸ The Ammogas furnace that Westinghouse engineers created took care of the heat-treating of costly parts like dies, which can be gas-hardened and are not produced in great quantities. But Ammogas is expensive—too expensive for



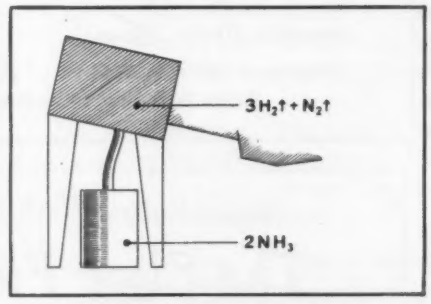
Here is an Ammogas Furnace.

the ordinary heat-treating of thousands of machine parts. And it is not suitable for heat-treatments requiring high temperatures.

So Westinghouse engineers developed Endogas—a special atmosphere which would do large-quantity, high-temperature heat-treating jobs, and do them at low cost. They heated ordinary gas (natural or manufactured city gas is all right) and, by a special but inexpensive process, changed it into a gas rich in hydrogen and carbon monoxide and containing a little water vapor and carbon dioxide.

Endogas doesn't do its work by *avoiding* all decarburizing agents, carbon dioxide and water vapor; it *overpowers* them by the inclusion of agents like carbon monoxide and methane that work in the opposite direction.

In effect, Endogas maintains a balance between carburizing and decarburizing forces. This balance can be so closely controlled that it is even possible to *add*



A diagram of the Ammogas furnace.

carbon to the steel that's being heat-treated.

Today, the Ammogas and Endogas furnaces are hard at work heat-treating dies, castings, airplane parts, steel parts of all kinds, helping to turn them out faster and better—saving industry time, money, and mistakes—speeding crucial war production.

★ ★ ★

There is one reason why Westinghouse was able to create controlled atmosphere furnaces and lick decarburization. It is because Westinghouse is an engineer's company.

There are 3,500 engineers in Westinghouse . . . in service, in sales, in design, in research, in management, in every branch of the business. Engineers hold key positions in each of the 17 Divisions of the Westinghouse Company.

Engineers determine our ability to find better ways to get jobs done. Engineers direct the creation and manufacture of our products. Upon engineers our success depends.

Behind our training and our encouragement of individual effort, there is a definite purpose. Behind our organization set-up of many divisions, which are like small companies within a company, there is a definite purpose. That purpose is to develop young engineers like you into the kind of engineers who will take good care of our future.

Westinghouse

"An Engineer's Company," Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.

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Engineers who like a durable, compact, easily read steel tape take special note of the Lufkin "Ranger." Its sturdy, flexible steel line is ¼" wide with jet back markings that stand out prominently against the smooth, satin chrome surface. Graduations in feet, tenths and hundredths—or feet, inches and eighths. See it at your dealer's and write for free Catalog 12.
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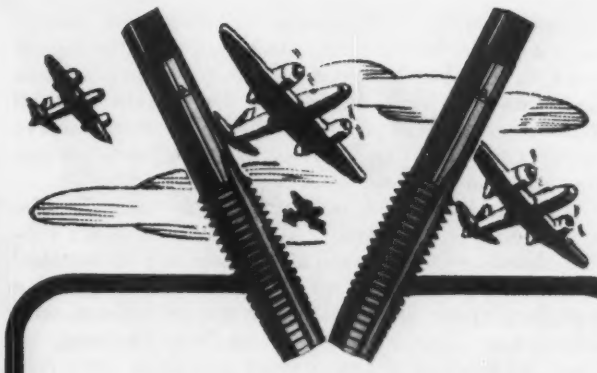

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"Greenfield" Taps, Dies and Gages are helping to build practically every plane and engine used by our Army and Navy.

70 years of practical experience enable these tools to meet Uncle Sam's most rigid requirements. That experience is one reason why skilled workers and production men always have confidence in *"Greenfield"* tools.

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"FM — BROADCASTING'S SUPERHIGHWAY"

(*Continued from page 43*)

not worth much. But FM offers reliable day or night reception virtually immune from static, system noise and station interference, and with an amazing fidelity that makes a real investment for best tone quality worthwhile.

Well over a hundred stations are trying to get on the air with FM, some thirty or more of them operating at the present time. For purely economic reasons, most of the low power or local stations now broadcasting on the standard AM band should sooner or later be tempted to switch to FM. The initial cost is not great. They would save on operating expenses for tubes, for current and man-power, since it is not necessary to monitor an FM transmitter to keep it from overloading on peaks; it always transmits at rated power regardless of the volume of the program.

The FM broadcaster has a better proposition to offer to advertisers. He is licensed to cover a definite area, based on a marketing center and he guarantees to deliver a usable signal to that same potential audience day or night. He is protected from interference of other stations in that area. His audience has adequate purchasing power. He keeps their interest with good programs delivered with amazingly lifelike fidelity.

This protection against interference from other stations is achieved by the special circuits in Armstrong-licensed FM receiving sets. With this feature, though two FM stations or an FM station and an AM program (or amplitude-modulated static) might be coming into the receiver at the same dial position at the same time, the strongest FM signal gets the green light and all other programs or noises are blacked out so that only one program is heard at a time.

As proof of this, two FM stations were tuned to the same frequency some seventeen miles apart, each with a different program so one could be told from the other. Experiments with a receiving set mounted in a truck showed that control would switch from one station to the other while traversing a small "no man's land" or cross-over point between them so that only one program could be heard at a time. Listeners in the licensed service area of each station would hear that station alone, the interference from the other transmitter being blacked out in his receiving set before reaching the loud speaker.

On a smaller scale, experiments of this type were also conducted in the same room at an A.I.E.E. convention at Swampscott, Mass. Two little transmitters were operated diagonally across the room with a receiving set between and it was shown how one transmitter could take control away from the other or vice versa. This means that on FM — broadcasting's new superhighways — 100,000 or more broadcasting stations could be scattered across the country, each serving its own licensed service area without interference. The channels used in New York City could again be assigned to stations in Newark, and listeners in New York would hear New York while New Jersey listeners would hear Newark. The forty channels assigned to this new FM band are wide enough to handle all audible sounds and

still transmit a facsimile picture on the same carrier at super-audible frequencies. An unused traffic island or guard band is left between adjacent channels so that (while it has not been established for certain that all forty channels can be used in the same community) every other channel can be used, allowing for a greater number of local stations than the present AM dial.

FM's one limitation is distance. Located in the ultra high frequency band, FM transmissions are reliable to about twice the optical horizon and reasonably good to four horizons. This allows for coverage of a large region where the transmitter can be located on a mountain top. Two FM stations in New England, for example, include six per cent more people in their reliable service range than all fifty-two standard AM broadcast stations in New England can count in their "primary" coverage. AM stations have a large secondary coverage of distant listeners, however, especially at night, which FM stations cannot reach. Thus, FM would seem to offer the best highway for local coverage while AM is capable of regional or transcontinental service.

How can FM bring about improved reception on the AM band? We have all experienced occasions when a new superhighway was constructed to replace an old automobile road, then the old road could be rebuilt to carry additional traffic by an alternate route.

Some of us look forward to the day when perhaps eight hundred of the present eight hundred and ninety AM stations will voluntarily shift to the FM band, giving improved local service. That would clear the AM dial so that it could be reassigned with wider channels, each cleared for *one high powered station* to cover the rural areas and long distances. These cleared-channel AM stations would not have FM's immunity to static, but they would, through reallocation of wider channels, be able to transmit high fidelity programs without interference.

Perhaps the FM dial will come to be known as the "Local" band, the AM dial as the "National" band, while the short wave is, of course, the "International" band. Thus, all listeners would enjoy better, quieter reception on new radio highways, especially those who listen on the new AM-FM sets.

LIGHT VS. SABOTEURS

(*Continued from page 34*)

3. Aid the guard and hinder the intruder by:

(*a*) Lighting the approach areas and not the building or apparatus to be protected.

(*b*) Utilizing glare in such a manner that the guards can see any would-be intruders without being seen themselves.

(*c*) Providing a high ratio of vertical to horizontal illumination in boundary areas making it easy for the guard to see an intruder, but difficult for the intruder to move rapidly over unfamiliar ground.

4. Provide complete reliability by:

(*a*) Using equipment that offers maximum resistance to weathering, corrosion or mechanical damage.

(*b*) Designing the system so failure of a single unit will not leave a dark vulnerable spot. Dual coverage or overlapping is the solution.

(*c*) Arranging power supply, wiring and control for complete reliability. Underground wiring or an overhead system with a loop circuit is recommended. Switching should be arranged so that the system can be turned on at several stations but only one carefully guarded master station where it can be turned off.

All manufacturing plants making essential war materials have or should have a fence of one kind or another around their property. The fence line and the area 25 feet inside to 50 feet or more outside is considered as a barrier to any would-be intruder and is the first and most important area that should be properly lighted. In the event there are some unfenced boundaries a 100-foot minimum "light barrier" must be provided.

When buildings or property are located on or face waterfronts, the shore line and the surface of the water 100 feet or more from the shore should be lighted.

Fence lines, unfortunately, have a gate or gates and it is these points that are especially vulnerable and hard to protect. For this reason they need the conventional fence lighting supplemented by additional lighting which decreases their vulnerability to possible attack.

Siding entrances and loading docks are even more vital areas and should be closely guarded as well as lighted. Any outdoor material storage areas or shrubbery located on or near the boundary are also important and provide excellent areas for the saboteur to lurk in without being seen. Steep earth banks and dead-end streets also must be considered as potential entrance points and should be adequately lighted.

Vulnerable Apparatus and Buildings

The following list of important and vital equipment and buildings are essential for operation of the plant and must be carefully guarded:

1. Substation or powerhouse.
2. Pump house or feed water apparatus.
3. Outdoor conveyors and interbuilding skid or truck ways.
4. Explosive and fuel storage.
5. Water towers.
6. Railway trestles.
7. Craneways.

These areas must remain in darkness and be surrounded by a protective wall of light rather than be lighted themselves.

Building a Wall of Light

Protective fencing around a property can be twice as effective in achieving its purpose of keeping out intruders if it is properly lighted and patrolled. For then, the saboteur not only has to cross the fence itself, but also a blinding, glaring wall of light that will make him readily visible to the patrolling guards inside.

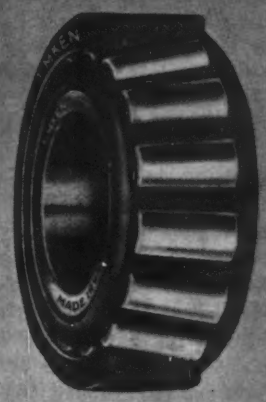
Fences can be effectively lighted by three commonly used methods, as shown in the sketches by (1) floodlights, by (2) street lights and by (3) fresnel units. Floodlights are used for relatively long straight fence lines on flat terrain where there is no objection to spill light on adjacent property. If navigable waterways, railroads or highways bound the property, glare must be avoided and consequently asymmetric street lighting units are usually employed. In the event that guards patrol along or just inside the fence line, there is an advantage in pointing all the floodlights in the direction of the guard's route, otherwise two floodlights pointed in opposite directions on each pole will generally prove more satisfactory.

For one-way floodlighting a 1,000 or 1,500 watt narrow beam floodlight should be mounted on a 25 to 30 foot pole spaced from 300 to 400 feet apart. The poles may be placed five to 10 feet inside the fence unless a solid board fence requires that the pole be erected on the fence line to avoid cut-off shadows.

(*Continued on page 48*)

Timken

Bearings are Keeping Wheels and Shafts Turning For Victory. They'll Keep Them Turning For Prosperity Afterwards.



Student engineers of today will have a terrific responsibility in the future; for upon their shoulders to a very great extent will fall the responsibility of developing new and better machines of all kinds to help in the reconstruction of the economic fabric of the nation.

A thorough knowledge of Timken Tapered Roller Bearings will be a valuable asset to every young engineer starting out on his career during the next two or three years—probably the most critical period our country has ever had to face.

Begin to acquire this knowledge now; write for a free copy of the Timken Reference Manual. Then you will be in position to master any bearing problem that may ever come up—no matter what combination of requirements it may involve; friction elimination; radial, thrust and combined load capacity; preservation of alignment of moving parts.

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TAPERED ROLLER BEARINGS

LIGHT VS. SABOTEURS

(*Continued from page 46*)

For two-way floodlighting two 1,000 watt narrow or medium beam floodlights should be spaced 400 feet apart or 500 watt floodlights at 300 spacing. It is advisable to mount them on 25 to 30 foot poles and to point them slightly outward to provide ample coverage of from 10 to 15 feet inside and 40 feet outside the boundary line. As in one-way floodlighting, the poles should be placed along the fence line if the fence is solid and five to 10 feet inside if the fence is open wire mesh.

Another method that provides effective lighting for boundaries consists of placing 500 or 1,000 watt horizontal spread-beam floodlights in groups of two at a height of 20 to 30 feet above the ground and from 50 to 80 feet inside the fence. Spacing will vary from 100 to 175 feet depending upon the distribution of the beam selected and the nature of the terrain. Directed at the boundary, this creates a tremendous glare condition that makes it practically impossible for would-be saboteurs to see into the property.

Street lights are especially useful where glare is undesirable. Asymmetric luminaires should be mounted on 25 foot poles placed 10 to 15 feet inside the fence, with the units supported by four foot brackets extending toward the boundary. If 10,000 lumen lamps are used, the poles should be spaced about 175 feet apart.

Fresnel units have recently been introduced and are especially designed for protective lighting where a wide horizontal and narrow vertical spread is required. This unit has a horizontal spread of 175 degrees and a vertical spread of only 18 degrees. On account of their wide horizontal spread they should be spaced at 125 foot intervals which will provide for sufficient overlapping of the beams.

Yards Also Require Protection

If complete protection is to be obtained, the area inside the boundary "wall of light" must also be considered. Medium and wide beam floodlights from 200 to 1,000 watt, depending upon the area to be covered, should be installed on poles or adjacent buildings. Important areas should be covered by at least two floodlights so the area is not left in complete darkness in case of an emergency. Shrubbery, trees, material storage, and entranceways to buildings all make excellent hiding places and should be well lighted. In contrast to these areas the following vitally important and strategic areas such as substations, oil fuel and explosive storage, feedwater apparatus and power houses should be kept in darkness and only the surrounding areas lighted. This method has proved more effective than any other in actually keeping saboteurs away from vulnerable apparatus.

Remote Areas and Unauthorized Entrances

There are various areas that do not fall into any of the previously described groups and consequently must be treated separately.

Waterfronts and docks require special consideration as they are favorite approaches of the saboteur. If part of the boundary line is a waterfront, the lighting problem is to avoid shadows and glare that would favor the saboteur by making detection almost impossible. One method that is very effective consists of placing horizontal spread-beam floodlights or fresnel units in groups of two above 25 feet above the ground and from 50 to 80 feet inside the boundary or from the water edge. A sea wall or high bank will cast an appreciable shadow along the shore and consequently another method will have to be used. This method consists of mounting wide beam floodlights on 30 foot poles placed within 10 feet of the seawall or bank. Directed perpendicular to the direction of river traffic these units will provide adequate coverage 50 or more feet from shore with relatively no glare to navigation.

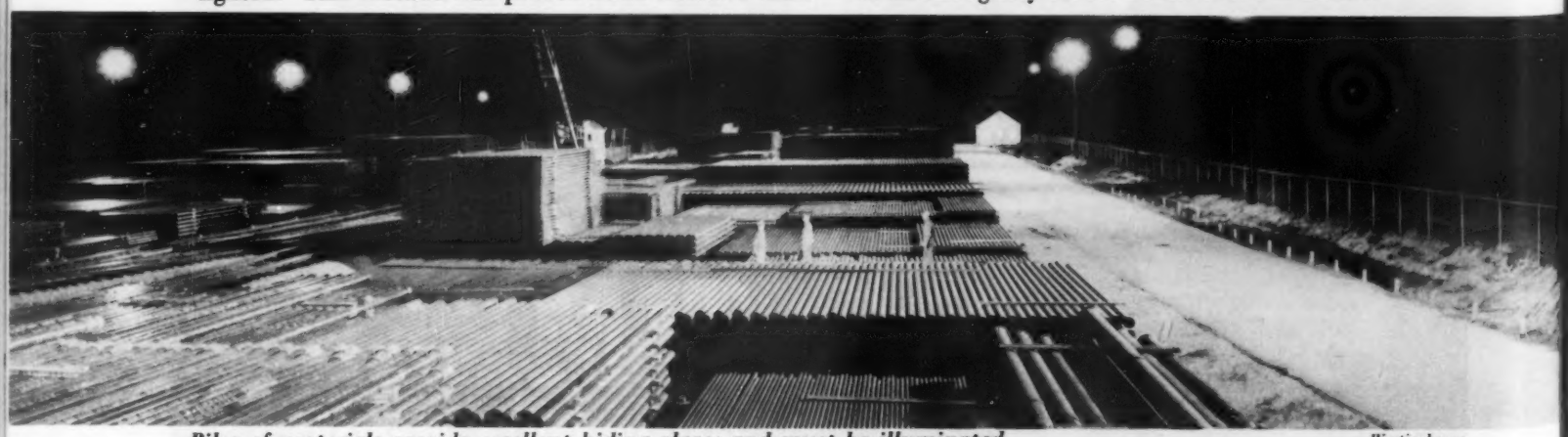
Authorized entrances include gates, and building entrances where persons may enter at night and watchmen are in attendance. Sufficient light should be provided to permit quick recognition of persons within 50 feet or more in any direction from the gate. The method of lighting as described for fences applies also to entrances.

Unauthorized entrances include locked gates, siding entrances, groups of trees or shrubbery near fence lines, storage areas or any points that are not considered as recognized or approved entrance points. Here, again, the fence lighting system includes these areas and the method of lighting is essentially the same.

As an emergency precaution, a remote-controlled searchlight should be mounted on top of the guard house or some high building to permit complete coverage of all vital areas and fence lines. Also, an adequate quantity of portable floodlights should also be kept in reserve to substitute for damaged equipment.

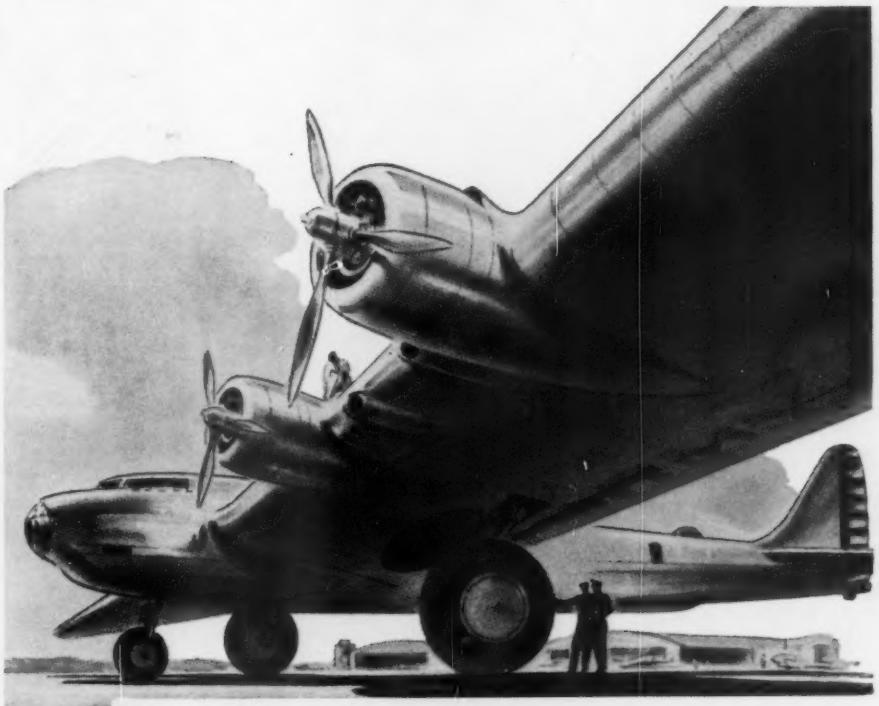
Wiring

Power supply and control circuits must be arranged for complete reliability by giving careful attention to protection of the wiring. Power must be supplied from the most reliable source available, and all of the installations should be equipped with automatic switchover to an emergency source in the event of failure.



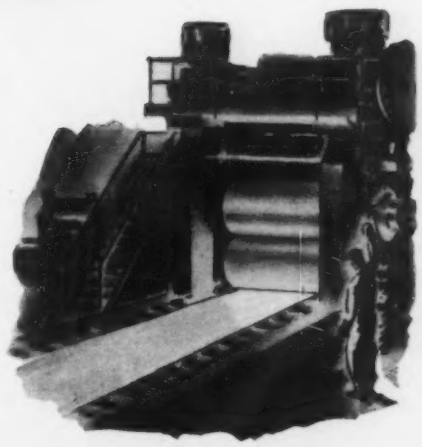
Piles of materials provide excellent hiding places and must be illuminated *Westinghouse*

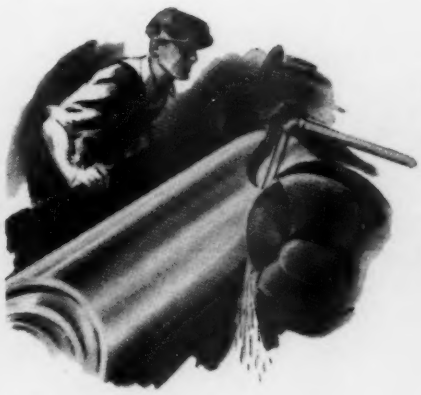
What does it take to smooth a Warbird's Feathers ?



A wingspread of 212 feet ...every inch preened sleek as satin! The perfect smoothness of the metal sheathing on American warbirds like the B-19, world's mightiest bomber, isn't there for looks. It's essential to top performance. How do they get the flawless sheets of metal used to make airplanes? They're rolled out by the ton by giant steel rolls. And keeping the surfaces of these rolls ground to almost perfect accuracy and finish is another of the vital contributions of Carborundum-made wheels to America's defense.

Thousands of other products for defense and for normal needs are made by the rolling process. Plate glass for your car, steel rails, plastics, tin plate and paper are only a few. And since their surfaces can be only as perfect as the faces of the rolls that roll them, finish is highly important. Today, surface quality of rolls can be maintained to within a few millionths of an inch by the use of Carborundum-made grinding wheels.





The same skill and experience that have helped develop modern roll grinding technique will be at your disposal in any industry with which you may become associated. Whatever the use of grinding wheels or coated abrasives, Carborundum engineers are ready at all times to advise and help. The Carborundum Company, Niagara Falls, New York.

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G-E Campus News

BLACKOUT WATCHMAN

THE problem of maintaining a night light in his place of business and at the same time complying with blackout regulations was solved by a Schenectady machine-shop owner by means of a G-E photo tube, or "electric eye." Rules required that all lights be extinguished within five minutes of an air-raid warning. That meant either hiring a watchman or turning out all lights at closing time.

The first night that the lights were turned out, the shop was broken into. So the owner, Andrew Tessier, put the "electric eye" to work. He installed the tube in an upstairs window, pointing at the nearest street light. When, during a practice blackout or raid warning, the street light is extinguished, the tube immediately turns out all lights in the shop. When the street lights go on again, so do the night lights. The "eye" provides a watchman who doesn't go to sleep on his job, and whose total cost is about two weeks' pay for an actual watchman.

MOLECULES MARCH!

WITH the increasing use of plastics and of artificial silk and rubber in defense activities, the structural qualities of the molecules that make up these materials is all-important to the scientists who are doing the research work.

Dr. Raymond M. Fuoss, of the General Electric Research Laboratory, in Schenectady, has found that some molecules wiggle like worms when an alternating electric field is applied to them. Such molecules are electrically lopsided, and when in an electric field they tend to line up, just as compass needles line up with the magnetic field of the earth.

From this tendency of the molecules to move to and fro in an electric field, scientists are able to determine how the various molecules are built. With this information, new molecules can be designed to meet specific needs. Since artificial silk and rubber and many plastics are composed of these worm-like molecules which react in an electrical field, materials of a wide variety of properties may be expected as a result of these researches.

NOT FOR WILLIE—

THE General Electric Company is proud of the variety of services it renders its customers. Nevertheless, company officials were surprised by one recent request from a woman who had seen a G-E advertisement in a magazine.

The illustration in the advertisement contained a picture of a young boy. The woman also had a boy, and her boy looked very much like the boy in the photograph.

Mother and son had only recently moved to New York. Since then, she had taken her son to a number of different barbers, but none of them had produced a haircut that suited her. And so, in desperation, she wrote to General Electric to find where the boy in the advertisement had his hair cut. It was just the type of cut she had vainly tried to get.

GENERAL ELECTRIC

955-34-211

The Murray Printing Company
Kendall Square, Cambridge